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VIRUSES IN WASTE, RENOVATED, AND OTHER WATERS

1973 LITERATURE ABSTRACTS

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VIRUSES IN WASTE, RENOVATED, AND OTHER WATERS

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Editorial Assistant: F. Dianne White

1973

BIOLOGICAL METHODS BRANCH
METHODS DEVELOPMENT AND QUALITY ASSURANCE RESEARCH LABORATORY
OFFICE OF RESEARCH AND DEVELOPMENT
NATIONAL ENVIRONMENTAL RESEARCH CENTER
U.S. ENVIRONMENTAL PROTECTION AGENCY
CINCINNATI, OHIO

1973

VIRUSES IN WASTE, RENOVATED, AND OTHER WATERS

Artykov, M. S. (1973). *Impact of Viruses in Waste Water on Agricultural Irrigation Fields.* **GIG SANIT, 38(4)**:110. Russian.

Enteroviruses were detected in soil, vegetables, and in the wastewater used to irrigate the soil in which the vegetables were grown.

Viruses were detected on vegetables that grow close to the ground (cucumbers), but not in those that do not contact soil or wastewater during the growing season.

More viruses were detected in the soil and on vegetables in the summer and autumn than during the other seasons.

Benarde, M. A. (1973). *Land Disposal and Sewage Effluent: Appraisal of Health Effects of Pathogenic Organisms.* **J AMER WATER WORKS ASSN, 65(6)**:432–40.

In a broad review of the microbiological problems in land disposal of sewage effluents, the virological problem is discussed.

Berg, G. *Reassessment of the Virus Problem in Sewage and in Surface and Renovated Waters.* **In "Progress in Water Technology," Vol. 3, edited by S. H. Jenkins. Pergamon Press, New York, New York** (1973), 87–94.

The bases for the problems of viruses in various waters, the effectiveness of virus removal by sewage and water treatment procedures, disinfection, and virus detection methodology are reviewed.

Relative concentrations of viruses and fecal coliforms in sewage and in river water, some from near water intakes, were found to fluctuate widely.

Virus adsorption to solids in water was shown to occur in important amounts.

The significance of detecting infection as well as disease in epidemiological studies designed to demonstrate water transmission was emphasized.

Because waters are long gone and often consumed before detection of bacteria and viruses can be achieved, a tentative standard for microbiological safety of potable waters based primarily upon disinfection criteria was recommended. Bacteriological and viral testing were recommended as important secondary backup.

Böthig, B., Kiessig, R., Burkhardt, R. (1973). *Coxsackievirus B6 Infections Among Children in the Magdeburg Area in 1971.* **Z GESAMTE HYG, 19(5)**:355–7. German.

Coxsackievirus B6 was recovered during routine sewage screening in Magdeburg, Germany during September and December 1970, and during January, February, and March 1971, although this virus had previously been absent from the spectrum of circulating enteroviruses. The virus was also recovered from water samples from swimming pools in June and July 1971. From January to July 1971, the same virus was recovered in the Magdeburg district from 16 sick children suffering a variety of symptoms. The virus may also have been the etiological agent of an outbreak of mild enteritis among children in the area.

Böttiger, M. (1973). *Experiences from Investigations of Virus Isolations from Sewage over a Two Year Period with Special Regard to Polioviruses.* **ARCH GES VIRUSFORSCH, 41**:80–5.

Viruses were recovered from almost all samples collected at the inlets of the three major sewage treatment plants in the Stockholm area during a two year period (1969–1970). Two or more types of enteroviruses or reoviruses were identified in one-third of the samples. Polioviruses were recovered from 11 samples.

Brisou, J., Denis, F. (1972). *Viral Contamination of Seafood – Incidences of Human Disease.* **ECON MED ANIMALES, 13(6)**:345–50. French.

Shellfish eaten raw or after rapid and superficial heating play an important role in the transmission of certain viral infections.

Shellfish constitute true filters. The oyster passes through its body from 30 to 100 liters of water every 24 hours, depending upon its weight and physiological activity. If toxic products or microbes exist in the environment only in traces or in very small numbers, molluscs will concentrate them at staggering rates. The oyster can concentrate certain pesticides up to 70,000 times, depending upon the initial level present in the water.

Viruses, however, are not easily detected because the number of virus particles present in water is often very low, and long and difficult concentration procedures need to be carried out to recover them. Recovery of viruses from water by concentration in oysters has been suggested.

Brown, E. R., Hazdra, J. J., Keith, L., Greenspan, I., Kwapinski, J. B. G., Beamer, P. (1973). *Frequency of Fish Tumors Found in a Polluted Watershed as Compared to Nonpolluted Canadian Waters.* **CANCER RES, 33(2)**:189–98.

Tumors were found in 4.4% of 2,121 fish from Fox River water as compared to 1.0% in 4,639 fish from Canadian waters. The Fox River was highly polluted; the Canadian waters were not. Toluene, crude oil, gasoline, benzanthracene, chlorinated hydrocarbons, phosphates, sulfates, and coliform bacteria were among the pollutants found in the Fox River. Dissolved oxygen content, temperature, and nutriments appeared to be similar in both water systems.

The pollutants are believed to be responsible for the greater frequency of tumors.

Brungs, W. A. (1973). *Effects of Residual Chlorine on Aquatic Life.* **J WATER POLLUT CONTRL FED, 45(10)**:2180–93.

Environmental variables did not usually significantly affect chlorine toxicity for aquatic life. At low pH levels, however, forxicity often increased as the result of the greater proportion of free chlorine present. Trout, salmon, and some fish-food organisms were more sensitive than warm-water fish, snails, and crayfish to chlorine compounds.

Chronic toxicity to growth and reproduction occurred at chlorine concentrations much lower than those that were acutely lethal. Lethal effects of chlorine usually occurred within 12 to 24 hours. Free chlorine was lethal at lower concentrations than chloramines. Dechlorination with sodium bisulfite, sodium thiosulfate, and sulfur dioxide reduced or eliminated chlorine toxicity.

Total chlorine concentrations in waters receiving continuously chlorinated wastes should not exceed 0.01 mg/liter to protect resistant aquatic organisms, and should not exceed 0.002 mg/liter to protect most aquatic organisms. Total chlorine concentrations in waters receiving chlorinated wastes intermittently should not exceed 0.2 mg/liter for more than two hours a day to protect more resistant species of fish, and should not exceed 0.04 mg/liter for more than two hours a day to protect trout and salmon. If free chlorine persists in areas with populations of trout and salmon, total chlorine levels should not exceed 0.01 mg/liter for more than 30 minutes a day.

Substitutes for chlorine for disinfecting wastewaters and cooling waters should be sought, but should be used only after adequate acute and chronic toxicity studies have determined the potential environmental impact of the substitute.

Buras, N. *Recovery of Viruses from Waste Water and Effluent by the Direct Inoculation Method.* **In "Proceedings of the Conference on Environmental Quality Research." Technion-Israel Institute of Technology, Haifa, Israel** (1973), 19–31.

Chloroform or antibiotic-treated sewage and effluent samples were inoculated directly onto MK2 or Vero cell monolayers for enterovirus recovery. An average of 4,496 PFU of enteroviruses were recovered per 100 ml of sewage, and an average of 5,684 PFU of enteroviruses were recovered per 100 ml of effluent.

The ratio of viruses to coliforms was 1:20,000 in sewage and 1:2,000 in effluent.

Chiurco, A. A., Sutnick, A. I., Cerda, J. J., London, W. T., Blumberg, B. S. , Raunio, V. K. (1973). *Antibody to Australia Antigen in an Outbreak of Hepatitis on an Indian Reservation.* **RES COMMUN CHEM PATHOL PHARMACOL, 6(1)**:273–92.

A point source outbreak of hepatitis, unassociated with Australia antigen in the serum, occurred in a village on an Indian reservation. However, antibody to Au(1) was detected in 10% of the 40 patients with clinical acute hepatitis and in 27% of 26 clinically well contacts with elevated SGPT. Acute disease was more common in males; antibody was more commonly detected in females. Twenty-four percent of the contacts who received gamma globulin prophylactically developed icteric or anicteric hepatitis. The disease was mild and occurred principaliy in children.

These findings are consistent with the hypothesis that this outbreak was caused by an agent that shared some antigenic characteristics with Au(1), or that the outbreak was caused by Au(1) itself present in very low concentration or altered by some process in the pathogenesis of the disease.

Cohen, J., Shuval, H. I. (1973). *Coliforms, Fecal Coliforms, and Fecal Streptococci as Indicators of Water Pollution.* **WATER, AIR, & SOIL POLL, 2**:85–95.

The presence and survival of coliforms, fecal coliforms, and fecal streptococci in sewage treatment plants, heavily polluted rivers, a lake, and other drinking water sources were determined.

The fecal streptococci were more resistant to the natural water environment and to purification processes than the other indicator organisms and, at points distant from the original source of pollution were often the only fecal indicators detectable. In two of the systems studied, the survival of the fecal streptococci reflected the survival of enteric viruses better than the coliforms. Thus, fecal streptococci may sometimes provide a better estimate of the probable virus content of lightly contaminated water than the other two indicators.

Cooney, M. K. (1973). *Relative Efficiency of Cell Cultures for Detection of Viruses.* **HEALTH LAB SCI, 10(4)**: 294–302.

In a comparative study, more adenoviruses and polioviruses were recovered from nasopharyngeal and fecal specimens in primary human embryonic kidney (HEK) cells than in WI-38 cells. Coxsackievirus B strains were recovered only in HEK cells. *Herpesvirus hominis* and echoviruses were recovered more frequently in WI-38 cells than in HEK cells and cytomegaloviruses and rhinoviruses were recovered only in WI-38 cells.

Culp, G. L., Culp, R. L., Hamann, C. L. (1973). *Water Resource Preservation by Planned Recycling of Treated Wastewater.* **J AMER WATER WORKS ASSOC, 65(10)**:641–7.

The effectiveness of treatment processes and disinfection in removing viruses from sewage and other waters is discussed within a general review of treatment particularly in relation to new advanced waste treatment facilities planned for Montgomery County, Maryland and the Occoquan basin.

DiGirolamo, R., Daley, M. (1973). *Recovery of Bacteriophage from Contaminated Chilled and Frozen Samples of Edible West Coast Crabs.* **APPL MICROBIOL, 25(6)**:1020–2.

Edible West Coast crabs *(Cancer magister* and *Cancer antennarius)* contaminated with coliphage T4 yielded about one percent of the virus (more than 100 PFU/gm) after 20 minutes at 100 C.

Boiled and unprocessed crabs yielded 40 and 29% of the virus, respectively, after 120 hours of storage at 8 C, and 55 and 42% of the virus, respectively, after 30 days of storage at –20 C.

Doeglas, H. M. G., Nater, J. P. (1973). *Epidemiological Study of Patients with Warts.* **NED T GENEESK, 117(6)**:216–20. Dutch.

From October 1970 to April 1971, an epidemiological study of 483 patients (10% of all new patients) in two dermatological practices in Rotterdam and The Hague showed a significant statistical correlation between visits to swimming pools, barefoot athletics, or hyperhidrosis and the occurrence of plantar warts. In men more than 20 years of age, however, no correlation could be made.

A correlation could be demonstrated also between nail-biting and the presence of periungual warts.

Dürkop, J. (1972). *Viruses in Agricultural Waters.* **Z GESAMTE HYG, 18(12)**:957–9. Translation presently not available. German.

Feinstone, S. M., Kapikian, A. Z., Purcell, R. H. (1973). *Hepatitis A: Detection by Immune Electron Microscopy of a Viruslike Antigen Associated with Acute Illness.* **SCIENCE, 182(12)**:1026–8.

Spherical particles, 27 nm in diameter, were detected by immune electron microscopy in the stools of patients acutely ill with hepatitis A. The particles were serologically specific for this disease, every hepatitis patient tested showing a serological response to this antigen.

Patients with hepatitis B or with acute infectious nonbacterial gastroenteritis (Norwalk) showed no serological response to the hepatitis A-associated particles.

The findings suggested that the 27 nm particles are the etiological agents of hepatitis A.

Foliguet, J.-M., Lavillaureix, J., Schwartzbrod, L. (1973). *Viruses and Water: II. General Review of the Methods Available to Detect Viruses in Water.* **REV EPIDEMIOL, 21(3)**:185–259. French.

Methods for concentrating small amounts of viruses from large volumes of water are reviewed. Included are forced flow electrophoresis, pressure ultrafiltration (through osmotic and soluble filters), coagulation, membrane adsorption, adsorption to precipitates of inorganic salts, ion exchange resins, insoluble polyelectrolytes, and iron oxide, two phase separation, floatation, and continuous flow ultra-centrifugation.

Gentles, J. C., Evans, E. G. V. (1973). *Foot Infections in Swimming Baths.* **BR MED J, 3(8)**:260–2.

In a swimming pool survey of a 10% random sample of all bathers, the incidence of *Tinea pedis* infections was 8.5% and of verruca 4.8%. The incidence of *Tinea pedis* infections was 21.5% in 205 adult males, 6.3%, in 288 boys, 3.3% in 60 adult females, and 0.9% in 220 girls. The incidence of verruca in juveniles was 4.2% in boys and 10.5% in girls.

Few swimmers took precautions to avoid foot infections.

Guidon, L., Pierach, C. A. (1973). *Infectious Hepatitis After Ingestion of Raw Clams.* **MINN MED, 56(1)**:15–9.

A review of shellfish-transmitted hepatitis A is presented along with a case-history of a suspected raw clam-associated case.

Hall, E. S. (1973). *Quantitative Estimation of Disinfection Interferences.* **WATER TREAT & EXAM, 22(3)**:153–74.

Using data from the literature on the chlorination of viruses and other microorganisms, the author devised an equation which he believes may enable optimization of plant design and control systems for disinfection.

Häufele, A., Sprockhoff, H. V. (1973). *Ozone Disinfection of Water Contaminated with Vegetative and Spore Forms of Bacteria, Fungi, and Viruses.* **ZBL BAKT HYG, 175(1)**: 53–70. German.

Five million coliphage T1 in water were destroyed in two minutes by 2.5 mg O_3/liter. High concentrations of coliphage T2 and T3 were also destroyed rapidly by ozone.

Three-hundred-thousand *Escherichia coli* were destroyed in tap water in less than three minutes by 0.16 mg O_3/liter at 13.5 C. *Serratia marcescens* and *Pseudomonas aeruginosa* were destroyed almost as quickly. *Candida albicans* was also very sensitive to ozone but a species of *Penicillium* was somewhat more resistant. *Bacillus anthracis* spores and spores of other species of *Bacillus* were more resistant.

Hawley, H. B., Morin, D. P., Geraghty, M. E., Tomkow, J., Phillips, C. A. (1973). *Coxsackievirus B Epidemic at a Boys' Summer Camp. Isolation of Virus From Swimming Water.* **J AMER MED ASSOC, 226(1)**:33–6.

During an outbreak of coxsackievirus B5 infections at a boys' summer camp on Lake Champlain, the virus was recovered from the lake by concentration on the polyelectrolyte PE 60.

Viruses were also recovered from clinical specimens obtained from campers and staff who suffered a wide variety of clinical symptoms.

The findings suggested that lake swimming water contaminated with viruses can be an important vehicle in enterovirus disease transmission.

Hilton, M. C., Stotzky, G. (1973). *Use of Coliphages as Indicators of Water Pollution.* **CAN J MICROBIOL, 19(6)**:747–51.

A consistent relationship was not found between coliform (MPN) and coliphage levels in sewage-polluted Hudson River water between March 15 and April 21, 1970.

Hloba, L. I., Lastovet's, L. M., Rotmistrov, M. M. (1972). *Adsorption of Viruses from Water by Some Minerals.* **MIKROBIOL ZH, 34(1)**:64–5. Ukrainian.

Polygorskite (attapulgite, bentonite, agloporite, vermiculite and silica gel adsorbed coxsackievirus B3 from water. Kaolin and polygorskite, treated with Al^{+++}or dimenthyldialkylammonium chloride, decreased survival of human amnion cells in cultures.

The minerals may be used for removing viruses from water.

Homma, A., Sobsey, M. D., Wallis, C., Melnick, J. L. (1973). *Virus Concentration from Sewage.* **WATER RES, 7(7)**:945–50.

Optimal conditions for concentrating polioviruses from large volumes of raw sewage were established.

Solids in the raw sewage, 1 µm or larger, were removed by textile clarifying filters without removing significant quantities of virus. After acidifying the clarified sewage and adding salts to enhance adsorption, viruses in the sewage were concentrated on a fiberglas.. depth filter and subsequently eluted in small volumes of elutant.

An 80 to 90% efficiency of virus concentration was achieved.

Horbowska, H., Wielopolska, H., Krolak, H. (1973). *Virologic Studies on Sewage in Warsaw in the Years 1966–1971.* **PREZEGL EPIDEMIOL, 27(3)**:103–8. Polish.

From 1966 to 1971, 372 sewage samples from the city of Warsaw yielded 139 viruses including 31 polioviruses (25 type 1, 4 type 2, and 2 type 3), seven group B coxsackieviruses (types 3, 5, and 6), four strains of coxsackievirus A9, 72 echoviruses (types 1, 6, 7, 9, 11, 12, 13, 15), 13 adenoviruses (types 1, 2, 3, 5, 6) and 12 unclassified viruses.

The numbers of polioviruses recovered did not correlate with vaccination programs or with the fractions of populations vaccinated. Peaks in adenovirus numbers occurred in the spring and fall and peaks in enterovirus numbers occurred in the fall and winter. The types of echoviruses recovered from sewage were the same as those recovered from hospitalized patients in the same period of time.

Horst, H. (1973). *Contamination of Effluents by Australia Antigen.* **ZBL BAKT HYG, 156(2)**:551–6. German.

Hepatitis B antigen was detected in the sewage of a hospital after antigenic material from an autopsied cadaver was discharged into the sewer system.

Horstmann, D. M., Emmons, J., Gimpel, L., Subrahmanyan, T., Riordan, J. T. (1973). *Enterovirus Surveillance Following a Community-Wide Oral Poliovirus Vaccination Program: A Seven-Year Study.* **AMER J EPIDEMIOL, 97(3)**:173–86.

The impact of oral poliovirus vaccination on the circulation of enteroviruses in two small New England cities was measured by virologic surveillance.

Sewage specimens, collected at weekly intervals over a seven-year period, revealed polioviruses regularly throughout the year with no seasonal variations. Other enteroviruses were recovered mainly in the summer and autumn, the same ones tending to appear each year.

Rectal swabs collected from infants and preschool children attending the Well Child Conference indicated that during the same period 7% of unvaccinated children excreted polioviruses, presumedly as a result of contact infection acquired from vaccinees. Serodifferentiation and temperature marker tests showed that the viruses recovered from the sewage and children were largely vaccine derived.

The continuous use of oral poliovirus vaccine had no apparent influence on the behavior of other enteroviruses, but dissemination of the vaccine strains through contact infection probably raised the level of herd immunity among young susceptible children.

Ioli, A., Abenavoli, S. M. (1973). *Persistence of Australia Antigen in Water.* **BOLL DOLL DELL INSTITUTO SIEROTERAPICO, 52(3–4)**:103–5. Italian.

Au antigen, added to distilled water or spring water in a concentration of 1,000 units/ml was detected by complement-fixation tests 16 days after seeding.

Jepson, J. D. (1973). *Disinfection of Water Supplies by Ultraviolet Radiation.* **WATER TREAT & EXAM, 22(3)**:175–93.

The destruction of viruses in water by ultraviolet light (UV) is briefly reviewed within a broad review of the principles and application of UV disinfection of water.

Kalitina, T. A. (1972). *A Method for Recovering Enteroviruses from Meat. I. Preparation of Meat Samples for Analysis.* **VOPR PITAN, 31(7–8)**:80–3. Russian.

Meat seeded with poliovirus 1 or echovirus 2 was homogenized in 0.15 M NaCl at pH 7.2 in a tissue grinder for five minutes at 8,000 rpm, centrifuged for 30 minutes at 3,000 rpm, and the liquid extract was etherized for 30 minutes under continuous shaking. Following removal of the ether by centrifugation and decantation, the extract was shaken with freon 113 which yielded a transparent, slightly opalescent virus-containing liquid.

Complete recovery of the seeded viruses resulted.

Kapikian, A. Z., Wyatt, R. G., Dolin, R., Thornhill, T. S., Kalica, A. R., Chanock, R. M. (1972). *Visualization by Immune Electron Microscopy of a 27-nm Particle Associated with Acute Infectious Nonbacterial Gastroenteritis.* **J VIROLOGY, 10(5)**:1075–81.

A 27-nm particle was observed by immune electron microscopy in an infectious stool filtrate obtained from an outbreak of acute infectious nonbacterial gastroenteritis in Norwalk, Ohio. Both experimentally and naturally infected individuals developed serological evidence of infection. This, along with other evidence suggested that the particle was the etiological agent of Norwalk gastroenteritis.

Katzenelson, E., Schechter, H., Biederman, N., Rotem, Y., Shuval, H. I. *Ozone Inactivation of Waterborne Viruses.* **In Proceedings of the Fourth Scientific Conference of the Israel Ecological Society, April 1973.**

Ozone concentrations ranging from 0.2 to 1.5 mg/liter destroyed 99.9% of poliovirus 1 in 40 minutes at 5 C. Lesser concentrations of ozone produced little or no destruction of the virus at 5 C.

Konowalchuk, J., Speirs, J. I. (1973). *An Efficient Ultrafiltration Method for Enterovirus Recovery from Ground Beef.* **CAN J MICROBIOL, 19(8)**:1054–6.

Coxsackievirus B5 seeded into beef was eluted with 0.1% peptone in PBS at pH 7.2 and recovered by ultrafiltration after clarification of the eluate by acid-base treatment. A 67% recovery efficiency was achieved.

Ultrafiltration was achieved under pressure through an Amicon PM-30 membrane.

Konowalchuk, J., Speirs, J. I. (1973). *Enterovirus Recovery with Vegetable Floc.* **APPL MICROBIOL, 26(4)**: 505–7.

Flocced lettuce extract, formed from centrifuged, purreed lettuce adjusted to pH 4.5, quantitatively adsorbed 100 PFU of coxsackievirus B5. The floc was dissipated by adjustment of its pH to 7.5 and all of the virus was recovered by elution with 10% fetal bovine serum and medium 199.

Chicory and parsley were equally effective concentrating agents.

Echovirus 7 and poliovirus 1 were concentrated almost as effectively as coxsackievirus B5 with these technics.

Kostenbader, K. D., Jr., Cliver, D. O. (1973). *Filtration Methods for Recovering Enteroviruses from Foods.* **APPL MICROBIOL, 26(2)**:149–54.

Coxsackievirus B1, echovirus 6, and poliovirus 1, seeded into meat, vegetables, bread, cakes, seafoods, and cheeses were recovered by ultrafiltration under pressure on Amicon PM-30 filters.

The viruses were eluted from the membrane by 3% beef extract. Recoveries of at least 80% were obtained.

Kott, H., Fishelson, L. *Survival of Enteroviruses on Vegetables Irrigated with Chlorinated Oxidation Pond Effluents.* **In Proceedings of the Fourth Scientific Conference of the Israel Ecological Society, April 1973.**

A factor in oxidation pond effluents accelerated the rate of poliovirus 1 inactivation by solar radiation (minimum of 0.35 cal/cm^2/min) on the surface of tomatoes and parsley. Chlorination of the effluents increased inactivation efficiency.

Six hours after contamination of the vegetables with seeded, non-chlorinated oxidation plant effluent, up to 2% of the virus was recovered from vegetables exposed to sunlight and up to 3% of the virus was recovered from vegetables kept in the dark. A maximum of 2% of the virus was recovered from vegetables contaminated with chlorinated effluent and exposed to sunlight, and a maximum of 8% was recovered when the vegetables were kept in the dark.

When the vegetables were contaminated by viruses in PBS solution, 17% of the virus was recovered after six days of detention in darkness.

After exposure to two radiation peaks at higher levels of solar radiation, viruses were not recovered from vegetable surfaces 28 hours after contamination.

Kott, Y. (1973). *Hazards Associated with the Use of Chlorinated Oxidation Pond Effluents for Irrigation.* **WATER RES, 7(6)**:853–62.

Eight mg chlorine/liter in oxidation pond effluents did not destroy algae effectively during two hours of contact. The chlorine did destroy more than 99.99% of the coliforms present.

Enterovirus counts decreased only from about 80/100 ml to 37 PFU/100 ml. *Vibrio Cholerae (El-Tor)* was destroyed rapidly under these conditions.

Kott, Y., Roze, N., Sperber, S., Betzer, N. (1973). *Bacteriophages as Viral Pollution Indicators.* **In "Proceedings of the Conference on**

Environmental Quality Research." Technion-Israel Institute of Technology, Haifa, Israel (1973), 99–118.

Poliovirus 1 and coliphage f2 introduced daily into a 350–liter experimental oxidation pond were not reduced in numbers by the treatment process. Naturally occurring coliphage were not reduced in numbers either.

Ratios of coliphages to human enteroviruses ranged from 1:1 to as high as 10^3:1.

During three outbreaks of waterborne diseases in small communities attributed to failure in water treatment procedures, coliphages and human enteroviruses were found in the water supplies.

Coliphages survived longer than human viruses in chlorinated oxidation ponds.

Kretschmer, E. (1972). *Water and Sewage as Transmission Factors in Viral Hepatitis.* **Z ARZTL FORTBILD, 66(10)**:1065–70. Translation presently not available. German.

Krusé, C. W., Kawata, K., Olivieri, V. P., Longley, K. E. (1973). *Improvement in Terminal Disinfection of Sewage Effluents.* **WATER & SEWAGE WORKS, 120(6)**:57–64.

With dosages of chlorine considerably below the breakpoint level, viral inactivation was greatly improved at a sewage treatment plant by improving sewage-chlorine mixing and by lowering the chlorine-sewage reaction pH. The combination of improved mixing and acid feed at a reaction pH of 5.0 was equivalent to viral disinfection with four times the chlorine dose, even with improved mixing, under existing plant conditions.

Increased viral disinfection resulted from the prolonged existance of some unreacted HOCl at low reaction pH and its more efficient contact with viruses brought about by flash mixing. Coliform destruction was not so much enhanced. The generally modest coliform reduction of 99.99% must have resulted from the short (10 minutes) contact time provided and the protection of bacteria in suspended solids.

To have increased the disinfection rate by increasing the chlorine dose alone would have resulted in more than 20 mg total residual chlorine/liter

in the effluent as compared to 3 mg/liter residual when flash mixing and acid feed were employed. The relative impact on the ecology of the receiving stream is obvious.

Lund, E. (1973). *The Effect of Pretreatments on the Virus Contents of Sewage Samples.* **WATER RES, 7(6)**:873–9.

Viruses were recovered from sewage and from sewage sludge, but not from the secondary sludge of activated sludge treatment. Valid quantitative estimates of virus numbers cannot be made in sewage or sludge from which solids have been removed.

Reexamination of samples after storage at –20 C for six months resulted in much reduced virus recoveries.

Lund, E., Roenne, V. (1973). *On the Isolation of Virus from Sewage Treatment Plant Sludges.* **WATER RES, 7(6)**:863–71.

Viruses were recovered from sludges of urban sewage subjected to biological and chemical treatment. Activated sludge contained fewer viruses than primary sludge contained.

Treatment with lime, ferric chloride, or alum removed viruses from raw sewage so that viruses could be recovered from the sewage sludge when they could not be recovered from the primary effluent.

Mack, W. N. (1973). *Poliovirus in a Water Supply.* **J AMER WATER WORKS ASSN, 65(5)**:347–8.

Viruses were recovered from 76% of 70 influent samples, 86% of 29 raw sludge samples, and from 60% of 68 unchlorinated effluent samples taken from the East Lansing, Michigan sewage treatment plant. Five-hundred feet downstream of the plant, viruses were recovered from 80% of 40 river water samples taken when non-chlorinated effluent was discharged, and from 45% of 36 samples taken when chlorinated effluent (1 mg/liter) was discharged.

Poliovirus 2 was recovered from the well water supply of a restaurant thought to be the source of several cases of gastroenteritis.

Majumdar, S. B., Ceckler, W. H., Sproul, O. J. (1973). *Inactivation of Poliovirus in Water by Ozonation.* **J WATER POLLUT CONTR FED, 45(12)**:2433–43.

A threshold concentration appears to exist for the inactivation of poliovirus 1 in distilled water by ozone, wherein ozone concentrations greater than one mg/liter appear not to increase the rate of virus inactivation.

In distilled water, one mg of ozone/liter destroyed 90% of the virus in two to four minutes at 20 C. Results with primary and secondary wastewaters were not significantly different at this ozone concentration.

Errors appeared in some of the calculations in this paper. A correction is to appear in a future issue of the journal.

Mazur, B., Paciorkiewicz, W. (1973). *Dissemination of Enteroviruses in the Human Environment. I. The Presence of Poliovirus in Various Parts of Vegetable Plants Grown on Infected Soil.* **MED DOSW MIKROBIOL, 25**:93–8. Polish.

A total of 123 experiments were performed with 13 species of plants grown in poliovirus-infected soil. The virus was detected 7 times (5.7%) in green parts of the plants, 50 times (40.7%) in ground parts, and 108 times (87.9%) in upper portion of the roots extending from the soil through an air layer into vessels containing virus-bearing water. Ten percent of the soil samples collected close to the contaminated water contained viruses.

These findings suggested the possibility of virus passage from water to soil by external capilaries along the roots.

Melnick, J. L., Berencsi, G., Biberi-Moroeanu, S., Combiescu, A. A., Furesz, J., Kantoch, M., Kostrzewski, J., Magrath, D. I., Perkins, F. T., Vonka, V., Cockburn, W. C., Dömök, I., Assaad, F. A. (1972). *WHO Collaborative Studies on Poliovirus Type 3 Strains Isolated During the 1968 Poliomyelitis Epidemic in Poland.* **BULL WLD HLTH ORG, 47(3)**:287–94.

An extensive outbreak of poliomyelitis caused by poliovirus 3 occurred in Poland in 1968 about four months after small vaccine trials with the *Leon* $12a_1b$ (Sabin) and *USOL-D bac* poliovirus vaccine strains had been carried out. Because of the temporal association of the vaccination trials with the outbreak, and because the first cases of disease appeared in the province in which the *USOL-D bac* vaccine trial was carried out, a detailed investigation

was made of the virus strains recovered from cases in the epidemic to determine whether these strains were wild or whether they were related to the vaccine strains used in the trials. All of the studies were made under code in four different laboratories.

The *rct* marker did not differentiate the epidemic strains from the vaccine strains. The McBride test and the elution marker test clearly separated the *Leon* $12a_1b$ vaccine strains from those recovered from the cases, but these tests did not differentiate the epidemic strains from the *USOL-D bac* strain or from wild poliovirus 3 strains.

Thus these studies did not determine the origin of the epidemic.

Metcalf, T. G., Wallis, C., Melnick, J. L. *Concentration of Viruses from Seawater.* **In "Advances in Water Pollution Research," edited by S. H. Jenkins. Proceedings of the Sixth International Conference, Jerusalem, June 1972. Pergamon Press, New York, New York** (1973), 109–18.

Virus concentrating equipment capable of sampling seawater at rates approaching 300 gallons/hour functioned efficiently in field trials conducted in salt water. Filters prepared from synthetic materials removed marine sedimentary material without retaining significant quantities of viruses thus making it possible to adsorb viruses from the clarified seawater onto virus-adsorbing filters.

Laboratory trials with artificial seawater demonstrated that the concentration methods recovered almost all viruses contained in the samples tested.

Mintzker, N., Kott, Y. *Chlorination of Effluents After Secondary Treatment.* **In "Proceedings of the Conference on Environmental Quality Research." Technion-Israel Institute of Technology, Haifa, Israel** (1973), 119–64.

Trickling filter effluents and oxidation pond effluents were chlorinated in the laboratory and in an experimental pilot plant and the inactivation rates for coliforms and *Escherichia coli* bacteriophage were determined.

The dynamics of the process is represented by a modification of the first-order reaction expression.

A nomogram is presented showing chlorine dose-detention time couplings required for given inactivation efficiencies.

Moore, B. *The Health Hazards of Pollution.* **In "Society of Applied Bacteriology, Symposium, Ser. 1."** (1971), 11–32.

The epidemiological evidence for the transmission of virus diseases by water is reviewed within a general survey of waterborne disease transmission.

Studies on the viral etiology of acute gastroenteritis are also reviewed.

Nacescu, N, Brandis, H., Werner, H. (1972). *Recovery of Two Bacteriodes fragilis Phages from Sewage and Detection of Lysogenic B fragilis Strains.* **Z. BAKT HYG, 219(4)**:522–9. German.

Two phages with identical host spectrums were recovered on *Bacteroides fragilis AI 125* from two samples of sewage taken from the same treatment plant. Both phages were specific for *B. fragilis.* Twenty-three of 68 *B. fragilis* strains tested were lysed by the phages. Other anaerobic and aerobic bacteria tested were not susceptible to the phages.

Eight strains of phages recovered on mixed cultures of *B. fragilis* strains included some that were lysogenic.

Nikolaevskaya, Z. S., Aizen, M. S. (1972). *Detection of Small Amounts of Viruses in Large Volumes of Water by Ultrafiltration through Lanthanum-Aluminum-Alginate Ultrafilters.* **VOPR VIRUSOL, 17(9–10)**:723–6. Russian.

Filtration of virus-seeded water through asbestos filters impregnated with sodium alginate, and subsequent concentration of the virus onto soluble La-Al-alginate ultrafilters resulted in complete recovery of the virus. A concentration factor of 400 to 500 was obtained.

With this method, viruses were recovered from 37% of the sewage samples tested (1–liter samples) from a Moskva River plant and from 37% of the Volga River (at Kalinin) water samples tested (3–liter samples).

Nupen, E. M., Stander, G. J. *The Virus Problem in the Windhoek Waste Water Reclamation Project.* **In "Advances in Water Pollution Research," edited by S. H. Jenkins. Proceedings of the Sixth International Conference, Jerusalem, June 1972. Pergamon Press, New York, New York** (1973), 133–44.

On routine monitoring, no viruses were recovered from the final effluent of the Windhoek Waste Water Reclamation Plant. Viruses were recovered from the mixed conventionally purified Goreangab Dam and reclaimed waters. Intensive testing of all other sources of water supply to the Windhoek area resulted in the recovery of viruses from raw natural water supplies and also from conventionally purified Goreangab Dam water.

On epidemiological evidence, the absence of *Escherichia coli I* from 100-ml samples of water has been a reasonably dependable indicator of the bacteriological safety of the water, but this standard does not guarantee the absence of all pathogenic organisms from 100 ml (or more) of the water. The absence of enteroviruses from 10–liter samples should indicate that a water is safe for drinking.

Break-point chlorination at low pH and low turbidity levels is of cardinal importance in the disinfection of reclaimed water and all other treated waters destined for drinking purposes.

The days of protected catchments and impoundments are over. The treatment in a conventional plant of what is virtually wastewater for drinking purposes is already a world wide practice. The major difference between this practice and the direct reclamation of wastewater is that in a tertiary system the process units are designed and controlled in accordance with environmental factors and variables.

Olivieri, V. P., Krusé, C. W., Hsu, Y. C., Griffiths, A. C., Kawata, K. *The Comparative Mode of Action of Chlorine, Bromine, and Iodine on f2 Bacterial Virus.* **In Preprints of Papers Presented at the 166th National Meeting of American Chemical Society, August 1973, Chicago, Illinois. American Chemical Society, Division of Environmental Chemistry, 13(2)** (1973), 144–50.

The halogens are general protoplasmic poisons and are effective disinfectants for a wide spectrum of microorganisms. Their modes of action on viruses, however, appear to differ.

Iodine reacts with the amino acid tyrosine in the protein moiety of the virus, but even in high concentrations has almost no effect on viral nucleic acid.

Bromine inactivates viral nucleic acid, but appears unable to penetrate the protein. The primary mechanism for inactivation by bromine probably involves the viral protein.

Chlorine readily inactivates the RNA in intact virus in a manner similar to that observed for the whole virus with respect to contact time and pH.

Palfi, A. *Survival of Enteroviruses During Anaerobic Sludge Digestion.* **In "Advances in Water Pollution Research," edited by S. H. Jenkins. Proceedings of the Sixth International Conference, Jerusalem, June 1972. Pergamon Press, New York, New York** (1973), 99–104.

The virus concentration in digested sludge was 0.85 MPNCU/100 ml while that in raw sludge was 17.9 MPNCU/100 ml. This is equivalent to a reduction of about 95%.

Digested sludge is a potential source of infection and as such should be handled as an infectious material.

Pike, E. B., Curds, C. R. *The Microbial Ecology of the Activated Sludge Process.* **In "Society of Applied Bacteriology, Symposium, Series 1."** (1971), 123–47.

As part of a broad review on the microbial environment in activated sludge, the removal of viruses by this process is discussed briefly.

Poynter, S. F. B., Slade, J. S., Jones, H. H. (1973). *The Disinfection of Water with Special Reference to Viruses.* **WATER TREAT & EXAM, 22(3)**:194–208.

A comprehensive review of water disinfection is presented with a focus on viruses. The disinfectants discussed are chlorine, iodine, ozone, ultraviolet light, and ionizing radiation. Mechanisms of disinfection are also discussed.

Pozhar, V. N. (1973). *Viability of Enteroviruses in the Alkaline and Acid Effluents of the Gaysk Ore Dressing Combine.* **GIG SANIT, 38(4)**:101–2. Russian.

In alkaline industrial wastewater (pH 11 to 13.5) and in acid industrial wastewater (pH not given), poliovirus 2, coxsackievirus B3, and echovirus 7, seeded in concentrations of 10,000 $TCID_{50}$ /ml, survived for 11 to 18 days at 16 to 20 C.

In river water, these viruses remained viable for 29 to 35 days in this temperature range. Survival times increased somewhat at lower temperatures. Chemicals in the acid and alkaline wastewaters were believed to diminish the period of viral survival.

Rehacek, J., Fischer, R. G., Luecke, D. H. (1973). *Friend Leukemia Virus (FLV) Elimination in Feces of Flies and Fleas.* **ACTA VIROL, 17(3)**:167.

In two of 12 experiments, *Ctenoclphalides felis* (cat flea) fed on viremic mice infected with Friend's leukemia virus (FLV) excreted the virus in its feces from two to 24 hours after the infectious meal.

Stomoxys calcitrans (stable fly) did not excrete detectable amounts of FLV after blood meals on infected mice or after feeding on infected spleen.

Rubenstein, S. H., Fenters, J., Orbach, H., Shuber, N., Reed, J., Molloy, E. (1973). *Viruses in Metropolitan Waters: Concentration by Polyelectrolytes, Freeze Concentration, and Ultrafiltration.* **J AMER WATER WORKS ASSN, 65(3)**:200–2.

From 20 to 25% of echovirus 6 was recovered from 5–liter volumes of seeded river and lake water by a procedure of freeze drying followed by secondary concentration by ultrafiltration. More than 80% of poliovirus 1 seeded into tap water was recovered by the same process.

The PE60 procedure recovered less than 20% of poliovirus 1 and echovirus 6 seeded into 5–liter volumes of tap, river, or lake water.

Initial virus seed concentrations ranged from 20 to 50,000 PFU.

Schwartzbrod, L., Schwartzbrod, J., Doncoeur, F., Foliguet, J.-M., Lautier, F. (1973). *Viruses and Water: Enteroviruses and Treatment*

of Wastewater and of Drinking Water for Human Consumption. **REV EPIDEMIOL, 21(2)**:99–114. French

The capability of sewage and water treatment processes for removing viruses is reviewed.

Shechter, H. (1973). *Spectrophotometric Method for Determination of Ozone in Aqueous Solutions.* **WATER RES, 7(5)**:729–39.

A sensitive method based upon oxidation of buffered iodine and spectrophotometric measurement of the liberated triiodide ion was developed for measuring concentrations of ozone in the 0.01 to 2.0 mg/liter range. Reproducibility of results was very high.

This spectrophotometric method was more accurate and more sensitive than the volumetric method.

Shelton, S. P., Drewry, W. A. (1973). *Tests of Coagulants for the Reduction of Viruses, Turbidity, and Chemical Oxygen Demand.* **J AMER WATER WORKS ASSOC, 65(10)**:627–35.

Aluminum sulfate (15 mg/liter), ferric chloride (40 mg/liter), and ferric sulfate (62 mg/liter) removed 99 to 99.9% of coliphage f2 from seeded raw surface waters. A cationic flocculant and nonionic coagulant aids did not significantly improve the effectiveness of lower concentrations of the primary coagulants.

Turbidity removals of more than 90% were achieved with most of the coagulants and coagulant concentrations.

COD removals were generally less impressive.

Shuval, H. I., Gruener, N. (1973). *Health Considerations in Renovating Wastewater for Domestic Use.* **ENVIRON SCI & TECHN, 7(7)**:600–4.

Within a discussion of health-related areas in wastewater renovation, the occurrence and destruction of viruses is reviewed.

Šimková, A., Wallnerová, Z. (1973). *Survival of Small Amounts of Coxsackievirus A4 in Danube River Water Under Laboratory Conditions.* **ACTA VIROL, 17(6)**:505–6.

Coxsackievirus A4 was recovered after five months at 4 to 8 C in Danube River water (but not in normal saline) seeded with 320 LD_{50}/liter.

Detectable amounts of the virus still survived in the river water after 45 days at 20 to 22 C, but only when the starting concentration was 32,000 LD_{50}/liter.

Smith, J. E., McVey, J. L. *Virus Inactivation by Chlorine Dioxide and its Application to Storm Water Overflow.* **In Preprints of Papers Presented at the 166th National Meeting of American Chemical Society, August 1973 Chicago, Illinois. American Chemical Society, Division of Environmental Chemistry,13(2)** (1973), 177–85.

Chlorine dioxide (ClO_2) inactivated poliovirus and coliphage rapidly. No resistant viruses were found.

Demand by heavily contaminated water was slightly less severe for ClO_2 than for Cl.

Sobsey, M. D., Cooper, R. C. (1973). *Enteric Virus Survival in Algal-Bacterial Wastewater Treatment Systems – I. Laboratory Studies.* **WATER RES, 7(5)**:669–85.

In laboratory systems, a fraction of seed poliovirus 1 rapidly adsorbed to solids in stabilization pond water by a reversible process. The process was consistent with a Freundlich adsorption isotherm.

In laboratory cultures, the growth of *Scenedesmus quadricauda* and *Bacillus megatherium* in sterile sewage did not affect poliovirus 1 survival, but the growth of heterogeneous populations of stabilization pond bacteria in the same medium resulted in substantial loss of virus.

Appreciable poliovirus 1 inactivation occurred in laboratory cultures of algal-bacterial populations obtained from stabilization ponds. The degree of antiviral activity in these cultures was greater than that in cultures of stabilization pond bacteria.

The results of this study suggest that in algal-bacterial treatment systems both virus adsorption to solids and virus inactivation brought about by microbial activity play a role in reducing enteric virus numbers in wastewater.

Sobsey, M. D., Wallis, C., Henderson, M., Melnick, J. L. (1973). *Concentration of Enteroviruses from Large Volumes of Water.* **APPL MICROBIOL, 26(4)**: 529–34.

Acidification of clean waters allowed efficient adsorption of viruses onto epoxy-fiberglass and nitrocellulose filters in the absence of exogenously added salts.

Water was acidified with HCl prior to passage through a virus adsorber consisting of a fiberglass cartridge depth filter and an epoxy-fiberglass membrane filter in series. Adsorbed viruses were eluted with a 1–liter volume of pH 11.5 elutant and reconcentrated by adsorption to and elution from a small epoxy-fiberglass filter.

With this method, small quantities of poliovirus 1 in 100-gallon (378.5–liter) volumes of tap water were concentrated nearly 40,000-fold. An average virus recovery efficiency of 77% was achieved.

Sobsey, M. D., Wallis, C., Hobbs, M. F., Green, A. C., Melnick, J. L. (1973). *Virus Removal and Inactivation by Physical-Chemical Waste Treatment.* **J ENVIRON ENGIN DIV, ASCE, 99(6)**:245–52.

A package physical-chemical treatment plant (commutation, alum coagulation, carbon adsorption, diatomaceous earth filtration, and chlorination) removed 99.95% of poliovirus 1 seeded into raw sewage and more than 99.9996% of seeded virus from simulated river water.

Up to 2.6% of the seeded virus was recovered from filter cake solids.

Stevenson, J. H., Albright, L. J. (1972). *Isolation and Partial Characterization of a Marine Bacteriophage.* **Z ALLG MIKROBIOL, 12(7)**: 599–603.

A new marine bacteriophage (host is a *Cytophaga sp.*) with two distinct plaque types, a hexagonal head and a cross-striated tail, and no tail sheath is described. A smaller head occasionally occurred on the normal particles.

The distal end of the tail was thickened in specimens stained with phosphotungstate.

The $S_{20,w}$ n values of 187 S and 387 S may correspond to empty and intact phage heads, respectively.

Stringer, R. P., Cramer, W. N., Krusé, C. W. *Bromine, Chlorine, and Iodine Compared as Disinfectants for Amoebic Cysts.* **In Preprints of Papers Presented at the 166th National Meeting of the American Chemical Society, Chicago, Illinois, American Chemical Society, Division of Environmental Chemistry, 13(2)** (1973), 160–5.

In distilled water, bromine was superior to chlorine and iodine as a cysticide throughout the pH range 4 to 10. Halogen species predominating below pH 7 were more cysticidal than those predominating above pH 7.

In sewage effluent at pH 6, only iodine had significant value as a cysticide. At pH 8, chlorine, bromine, and iodine were all poor cysticides. Chlorine and bromine lost cysticidal potency in sewage probably because they combined with interfering substances.

Iodine, unlike bromine and chlorine, remains free in sewage and is the best halogen disinfectant for amoebic cysts in heavily contaminated water.

The Globaline tablet, which releases eight mg of iodine/liter and a buffer to lower water pH to 6.5 to 7, is the best disinfectant available for emergency supplies of drinking water contaminated with *Endamoeba histolytica* cysts.

Sullivan, R., Scarpino, P. V., Fassolitis, A. C., Larkin, E. P., Peeler, J. T. (1973). *Gamma Radiation Inactivation of Coxsackievirus B2.* **APPL MICROBIOL, 26(1)**:14–7.

Irradiation of coxsackievirus B2 in minimal essential medium by a cobalt-60 gamma source at temperatures of –30, –60, and –90 C resulted in D values of 0.69, 0.59, and 0.64 Mrad, respectively.

When the virus was suspended in water and irradiated at –90 C, the D value was 0.53 Mrad.

When the virus was irradiated in cooked ground beef at temperatures ranging from 16 to –90 C, the D values were 0.70 (16 C), 0.76 (0.5 C), 0.68 (-30 C), and 0.81 (-90 C) Mrad. Irradiation of the virus in raw ground beef at –30, –60, and –90 C yielded D values of 0.75, 0.71, and 0.68 Mrad, respectively.

All inactivation curves indicated first order reactions.

The rate of viral inactivation was clearly dependent on the suspending menstruum.

Sun, W., Little, L. W., Johnson, J. D. *Wastewater Disinfection of Trickling Filter Effluent with Bromine and Chlorine.* **In Preprints of Papers Presented at the 166th National Meeting of American Chemical Society, August 1973, Chicago, Illinois. American Chemical Society, Division of Environmental Chemistry, 13(2)** (1973), 156–9.

Reduction in demand of tertiary treated sewage allowed bromine to become the superior disinfectant at the same weight dosage as chlorine in the pH range 6 to 10.

Since tertiary treatment of sewage for phosphate removal may soon become mandatory, bromine may become an attractive alternative to chlorine.

Tierney, J. T., Sullivan, R., Larkin, E. P., Peeler, J. T. (1973). *Comparison of Methods for the Recovery of Virus Inoculated into Ground Beef.* **APPL MICROBIOL, 26(4)**:497–501.

One-hundred-gram samples of ground beef, seeded with poliovirus 1, were suspended in 150 to 900 ml of Eagle's minimal essential medium, pH 8.5, and mixed in either plastic bags or plastic cups on a mechanical shaker. The particulate materials were removed by filtration through cheese cloth, glass wool, woven fiberglass, or by low-speed centrifugation. Viruses in the large volumes of fluid were concentrated by ultrafiltration. Microbiological contamination was controlled by high antibiotic concentrations or by filtration.

From 20 to 50% of the seeded viruses were recovered.

Tsvetkova, S. A., Sobko, A. I. (1972). *Detection of the Foot-and-Mouth Disease Virus in Animal Slaughter Products.* **VETERINARIIA, 1(4)**:35–6. Translation presently not available. Russian.

Valenciano, L., Najera, E., Lozano, A. (1972). *Virological Study of Sewage. Its Importance in Epidemiology.* **REV SANIDAD HIG PUBLICA, 46(6)**:431–6. Spanish.

From February to September 1971, polioviruses, echoviruses and group B coxsackieviruses were recovered from Madrid sewage by the membrane filter technic. Most frequent recoveries were made between June and September.

Viraraghavan, T. (1973). *Water Quality and Human Health.* **J AMER WATER WORKS ASSN, 65(10)**:647–50.

In a comprehensive review of water problems, the author briefly discusses waterborne outbreaks of viral diseases.

Wallis, C., Melnick, J. L. *A Portable Virus Concentrator for Use in the Field.* **In "Advances in Water Pollution Research," edited by S. H. Jenkins. Proceedings of the Sixth International Conference, Jerusalem, June 1972. Pergamon Press, New York, New York,** (1973), 119–26.

An apparatus for the detection of viruses in large volumes of water is described. This virus concentrator lends itself to the monitoring of water reclamation plants to determine their efficiency in removing and inactivating viruses.

Welke, G., Friedrich, U., Mai, K. (1973). *Inactivation Time Determinations for Echoviruses 6, 11, 30, and 33 in Water.* **Z GESAMTE HYG, 5(5)**:353–5. German.

Survival of echoviruses 6, 11, 30, and 33, seeded into diluted river water maintained at 8 C, ranged from 0.1 to 30% after 300 days. Viable viruses were recovered 560 days after seeding.

At 20 C, inactivation of 10^5 to $10^{7.5}$ TCD_{50} of echoviruses 6, 11, 30, and 33/0.25 ml of diluted river water occurred in from 70 to 322 days.

Won, W. D., Ross, H. (1973). *Persistence of Virus and Bacteria in Seawater.* **J ENVIRON ENGIN DIV, ASCE, 99(6)**:205–11.

Small amounts of organic substances, including feces, increased bacterial survival in aerated sea water at 3 to 5 C. At 22 C, these organics promoted the growth of *Escherichia coli,* bringing about a 40-fold population increase and enabling viability to persist for 18 weeks.

Organic substances did not increase the survival of seeded echovirus 6. The inactivation rate for this virus was greater at 22 C than at 3 to 5 C.

Young, R. H. F., Burbank, N. C., Jr. (1973). *Virus Removal in Hawaiian Soils.* **J AMER WATER WORKS ASSN, 65(9)**:598–604.

All of the tailed coliphage T4 percolated in concentrations of greater than 10^6 PFU/ml through 2.5 inch depths of Wahiawa and Lahaina soils were retained in the soil filters. Breakthroughs occurred quickly in 1½ inch columns. Fifteen inches of Tantalus soil did not retain all of the virus.

More than 95% of poliovirus 2 was removed by 1½ inches of Wahiawa and Lahaina soils, and more than 99% of the virus, percolated through in concentrations of more than 10^5 PFU/ml, was removed by six inches of the soils. Only 35% of the virus was retained by 15-inch columns of Tantalus soil seeded with similar quantities of virus.

The Wahiawa and Lahaina soils are predominantly low humic latosols, and the Tantalus soil is a volcanic cinder from Hawaii.

All soil columns were 1½ inches in diameter. The maximum amount of water percolated through each filter was 30 inches (about 1,250 ml).

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